cirad
LA RECHERCHE AGRONOMIQUE
POUR LE DÉVELOPPEMENT

From biomass to fuel, power and chemicals

Brazilian charcoal-based pig iron

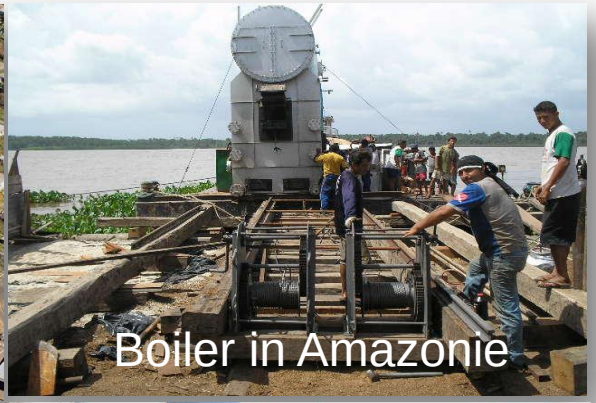
Dr. Patrick Rousset

Department of Aeronautics and Astronautics
National Cheng Kung University, Taiwan, ROC
November, 6th 2014

Brazilian experiences

Ethanol


Power plant

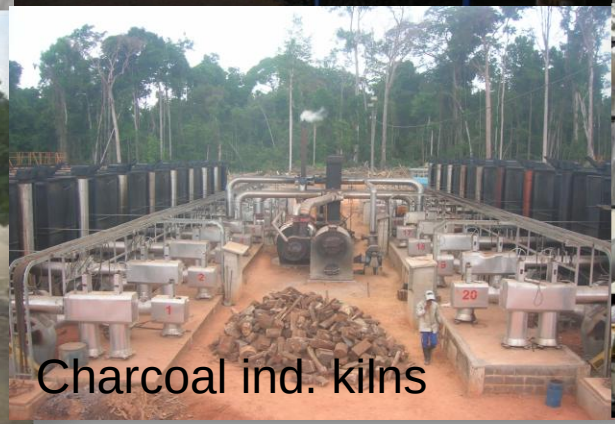

Boiler in Amazonie


Torrefaction


Pellets


Steam engine


Charcoal traditional kilns

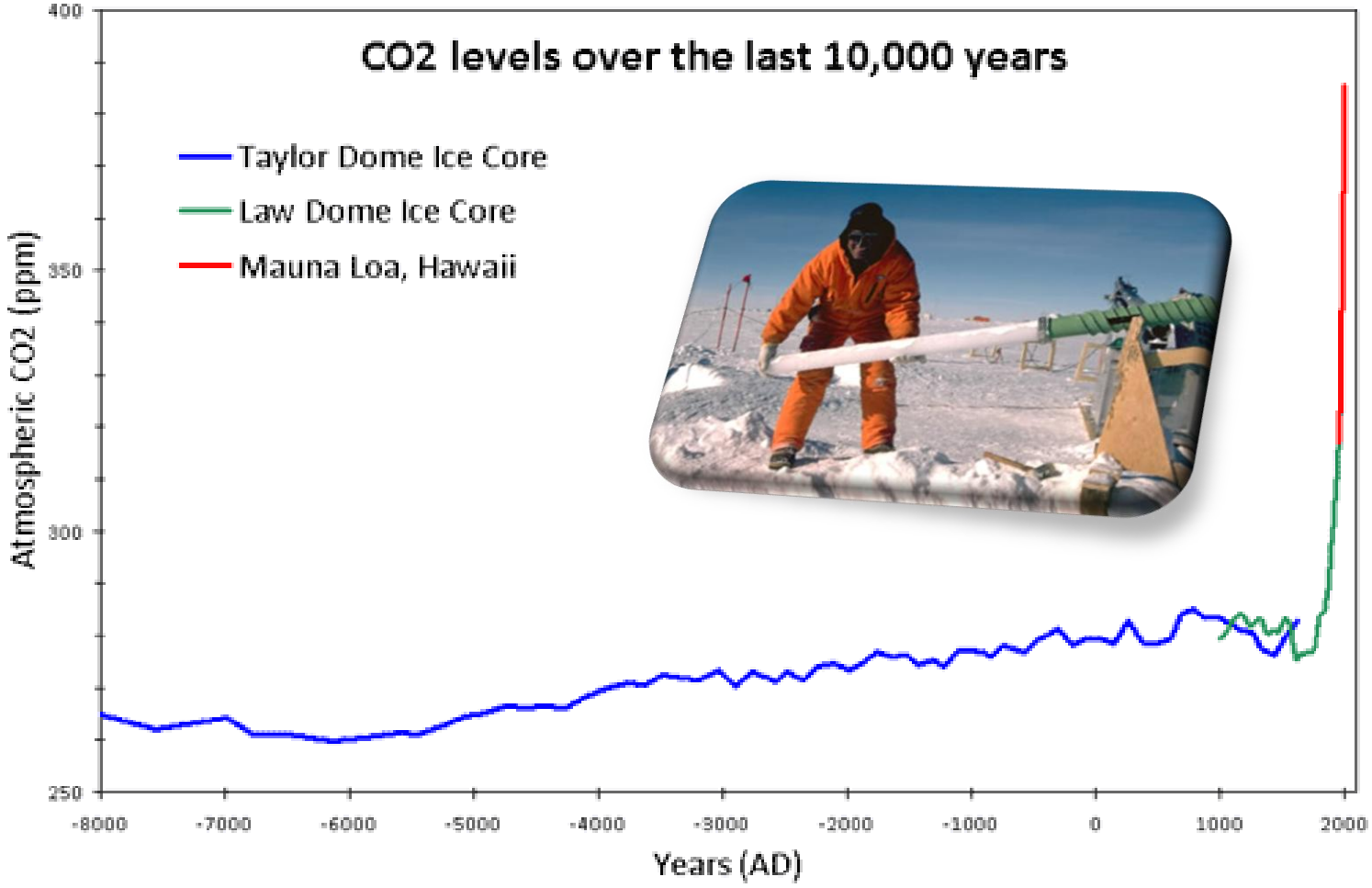

Charcoal ind. kilns


gazeification

Brazilian biomasses

cirad

CO2 Statement



Humans have increased the amount of CO2 in the atmosphere by 40% over the past 150 years, primarily through the combustion of fossil fuels

Considerations…

- Is biomass conversion with CO2 Capture and Storage (CCS) the solution
- Is biomass really renewable ?
- Is biomass a green substitute for fossils fuels?

Finally, is biomass perfect?

"Renewable energy is too expensive*"

"Biomass-burning power plants produce more global warming CO2 than fossil fuel plants: *150% the CO2 of coal, and 300 to 400% the CO2 of natural gas, per unit of energy produced* (HSAALA**)

"Burning whole trees in conventional power plants increases carbon emissions relative to fossil fuels for 35 to 100 years or more" (NRDC***)

What say skeptics?

* Montgomery, D., 2014
**American Heart Association and the American Lung Association
***Natural Resources Defence Council

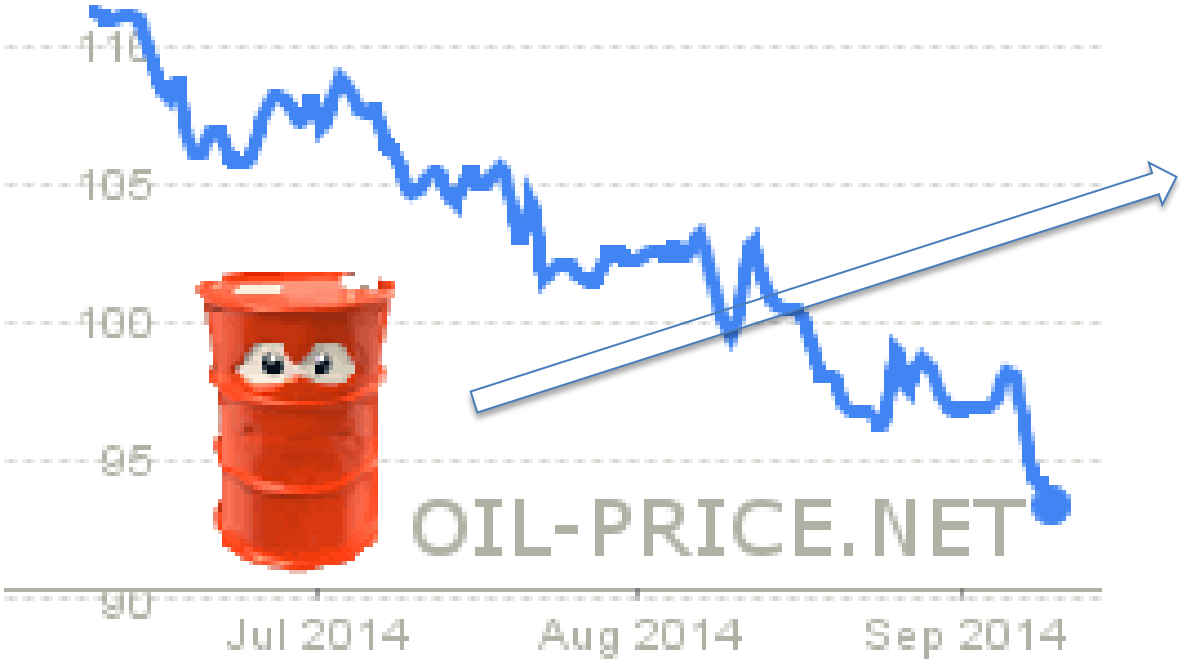
We have to consider what the alternatives are.

Whether or not biomass is truly carbon neutral, depends on:

- *what type of biomass is used,*
- *what technology,*
- *which fossil fuel is being replaced,*
- *what forest management techniques are employed,*
- *where the biomass is harvested...*

What I would like to say?

Other consideration: crude oil price



Brent crude dropped 20% for the quarter, the most in 2 years

=> Less research budget for renewable energy

STEVE AUSTIN for OIL-PRICE.NET, 2014/10/06

Brazilian Biomass Energy Experience

About Brazil: geography

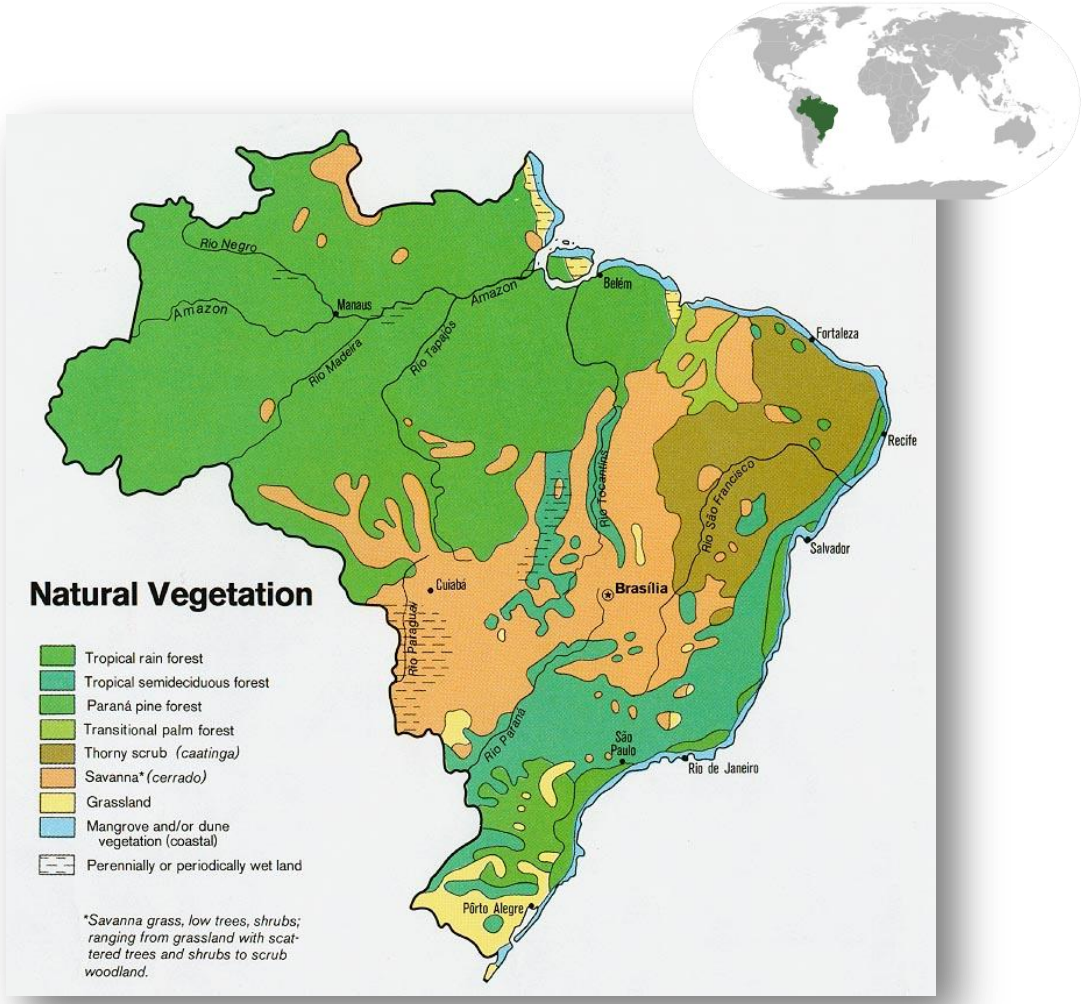
× 237

Taiwan total area 36,000 km²

× 18

France total area: 675,000 km2

× 12



Brazil total area of 8,500,000 km²

About Brazil: population

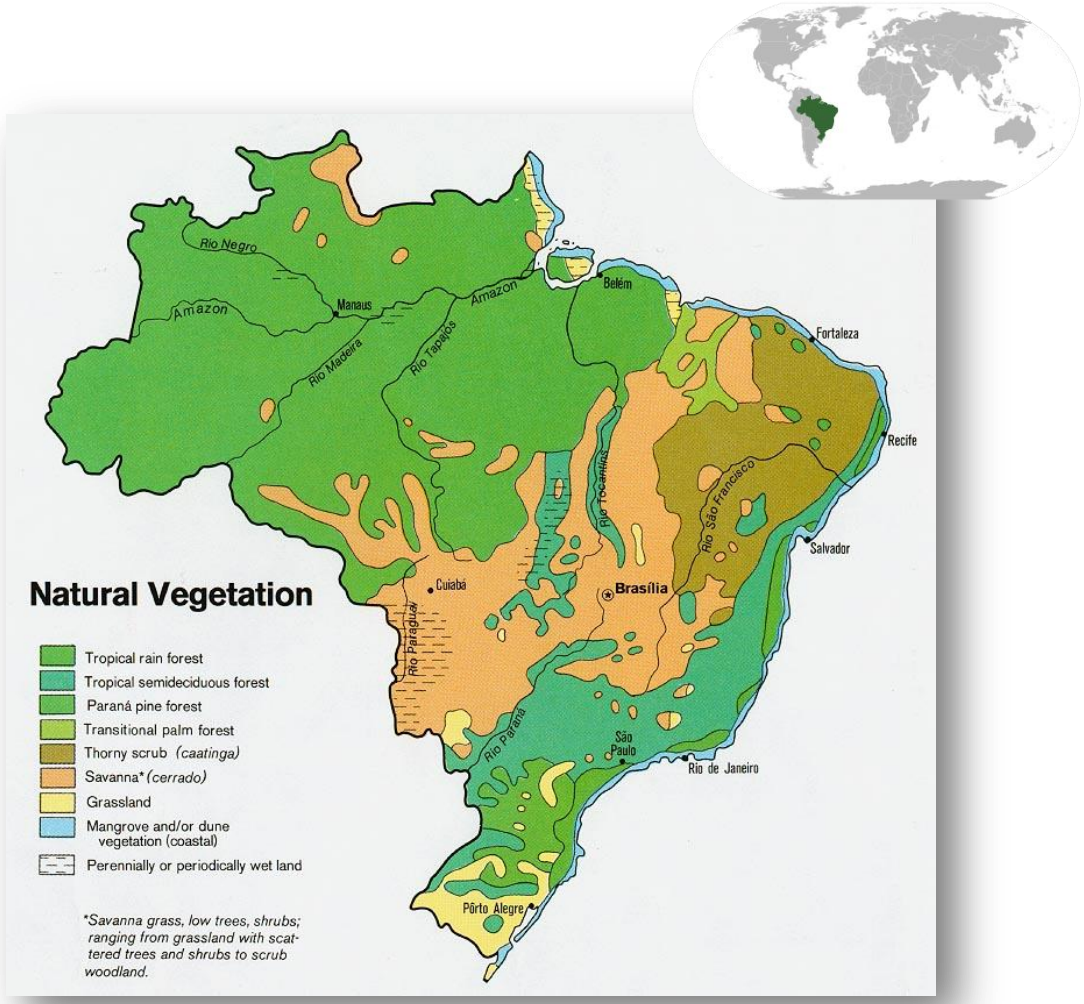
× 9

Population of over 23 million

× 3

× 3

Population of over 66 million



Population of over 200 million

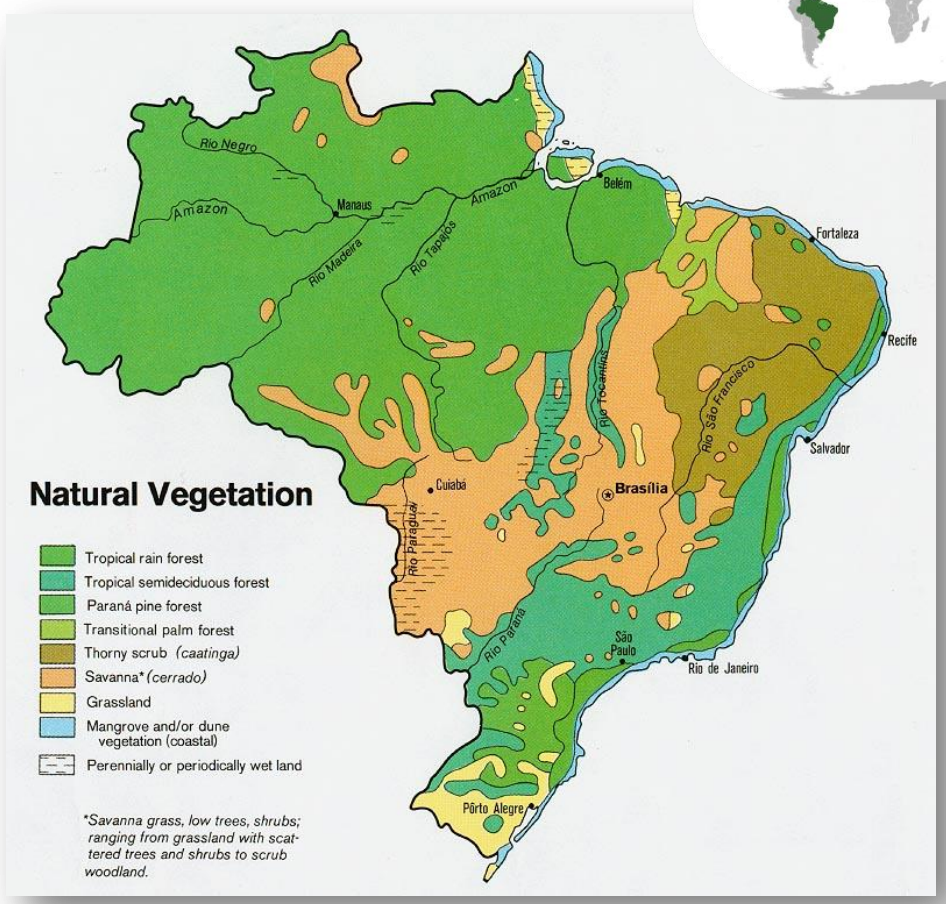
About Brazil : Gross Domestic Product

× 3

GDP/hab : 40.000$US

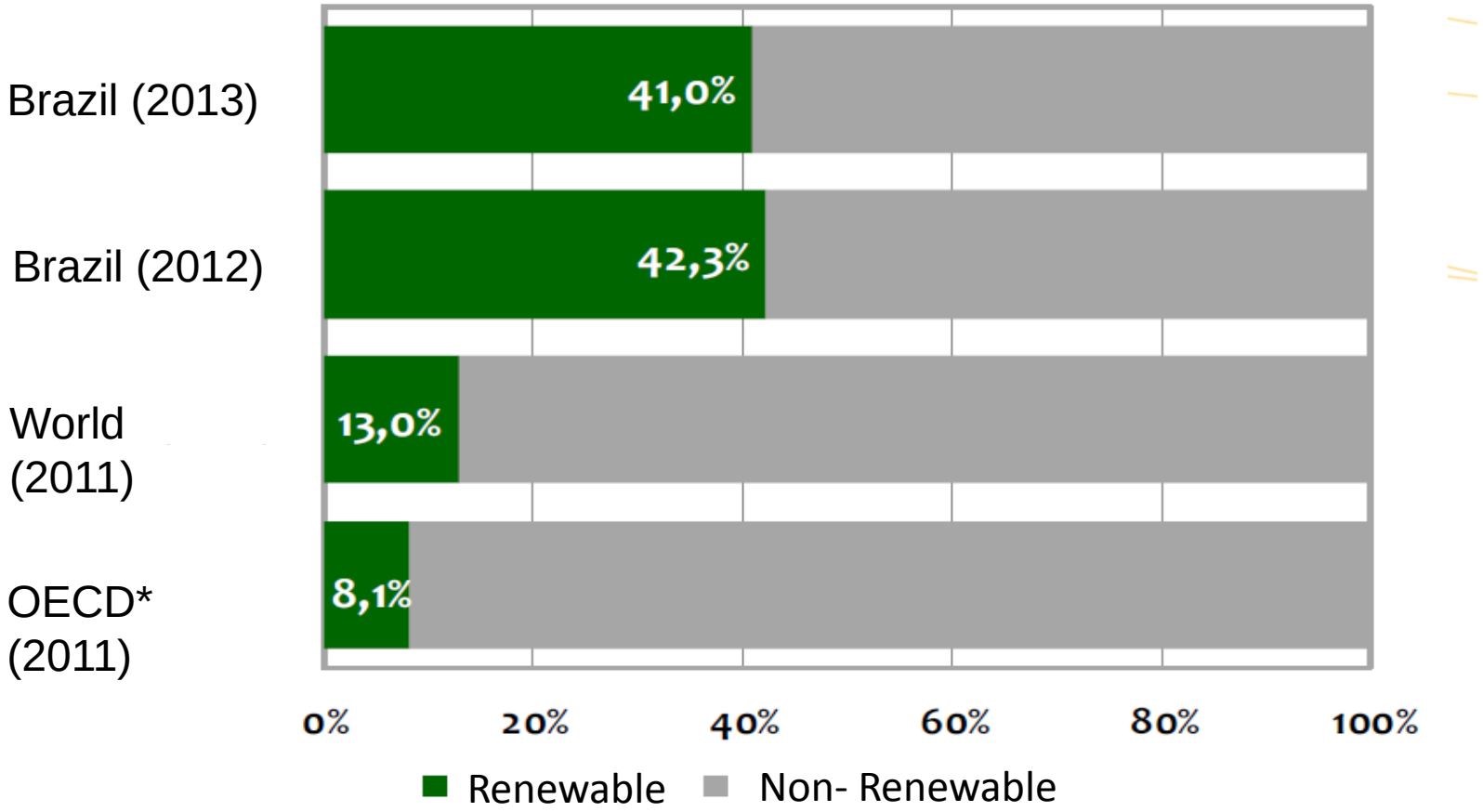
× 3

GDP/hab: 38.000$US



GDP/hab: 12.000$US

Gross domestic supply



Renewable Energies in the Brazilian matrix are the higher in the world

*Organisation for Co-operation and Development

Source: BEN2014, synthetic report,

Gross domestic supply

RENOVÁVEIS ▸ 41,0%

Sugar cane

16,1%

Hydrolic

12,5%

Firewood and charcoal

8,3%

Others

4,2%

¹ Inclui importação de eletricidade oriunda de fonte hidráulica

NÃO RENOVÁVEIS ▸ 59,0%

Crude oil

39,3%

Natural gas

12,8%

Coal

5,6%

Uranium

1,3%

Biomass = 25%

Source: BEN2014, synthetic report,

Energy users in Brazil?

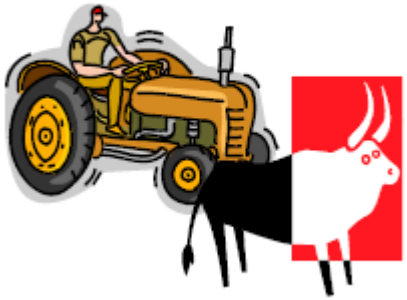
33,9%

32,0%

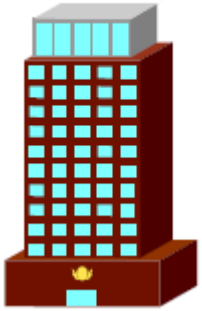
9,1%

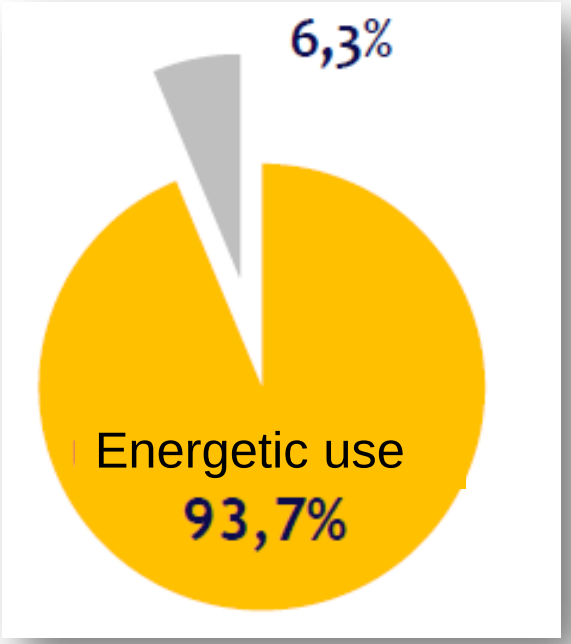
10,0%

4,1%



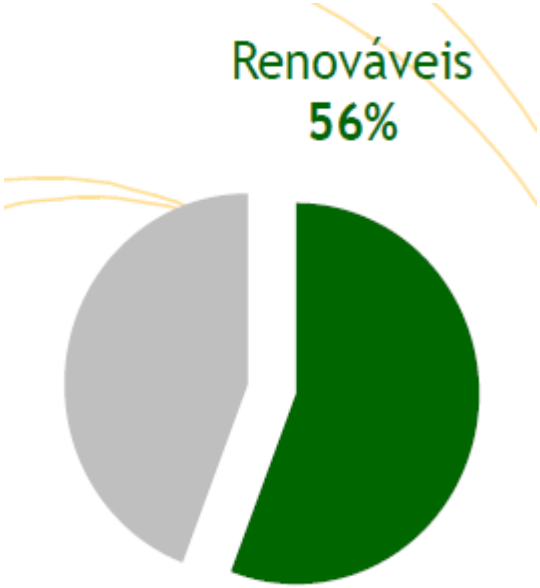
4,6%

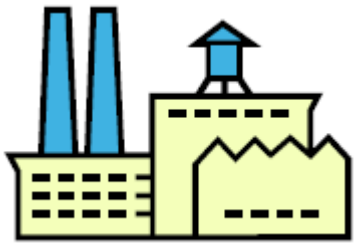




Source: BEN2014, synthetic report,

Renewable energy consumption/users





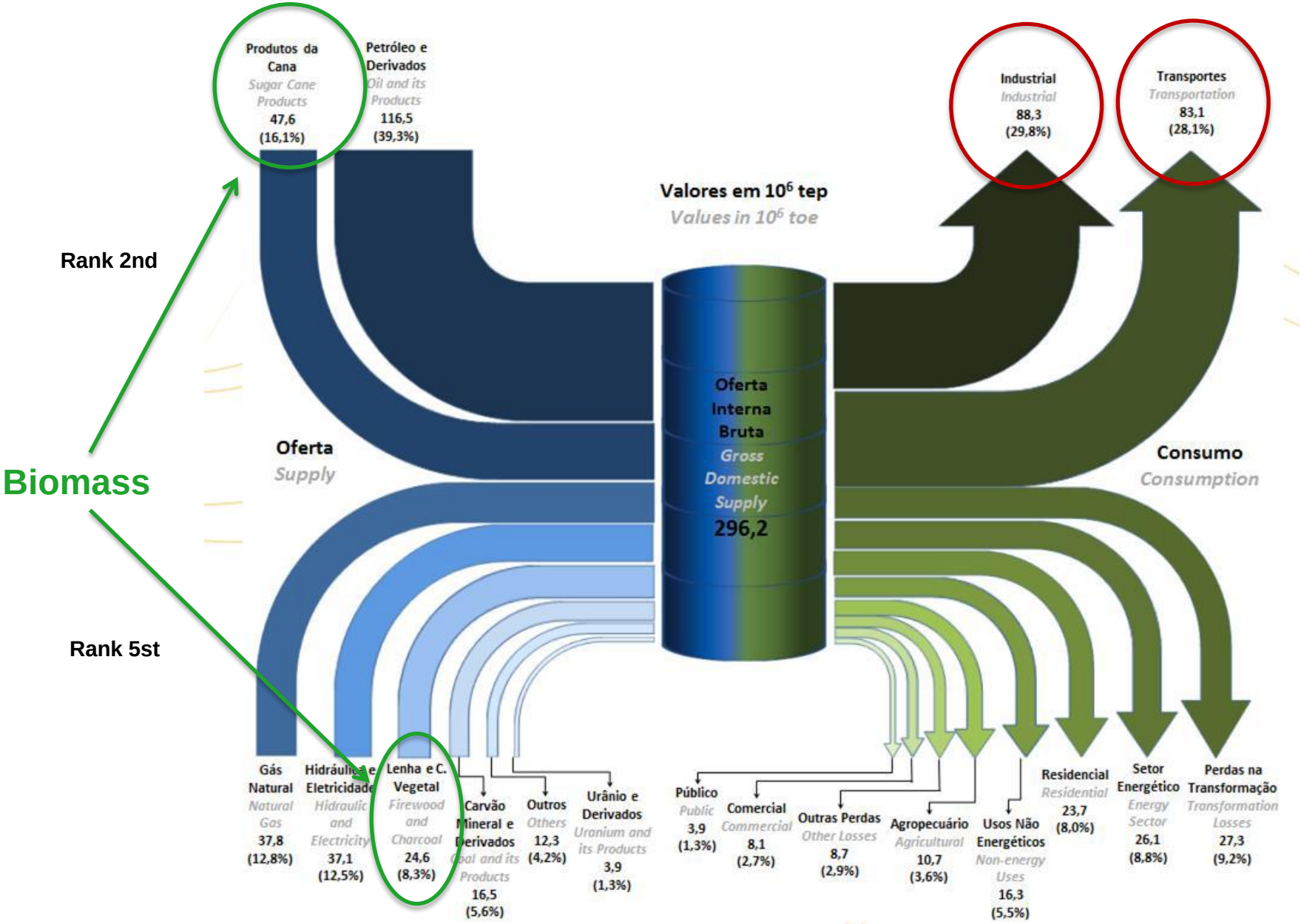
Biomass = 33%

Biomass = 16%

Biomass = 25%

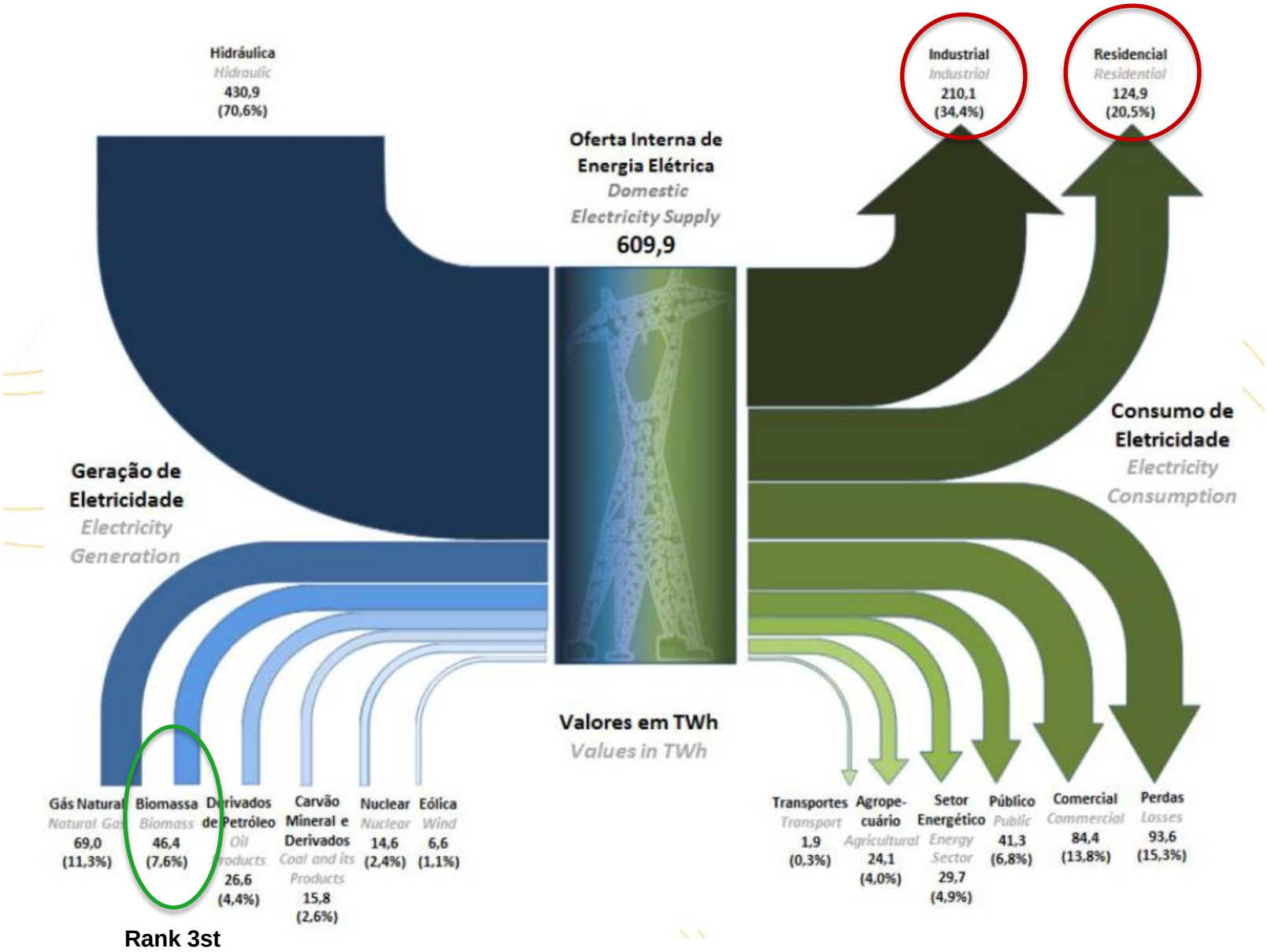
Source: BEN2014, synthetic report,

Gross domestic supply



Source: BEN2014, synthetic report,

Electiricity Supply



Rank 3st

Source: BEN2014, synthetic report,

Brazilian charcoal-based pig iron

Charcoal-based pig iron

Brazil accounts for approximately :

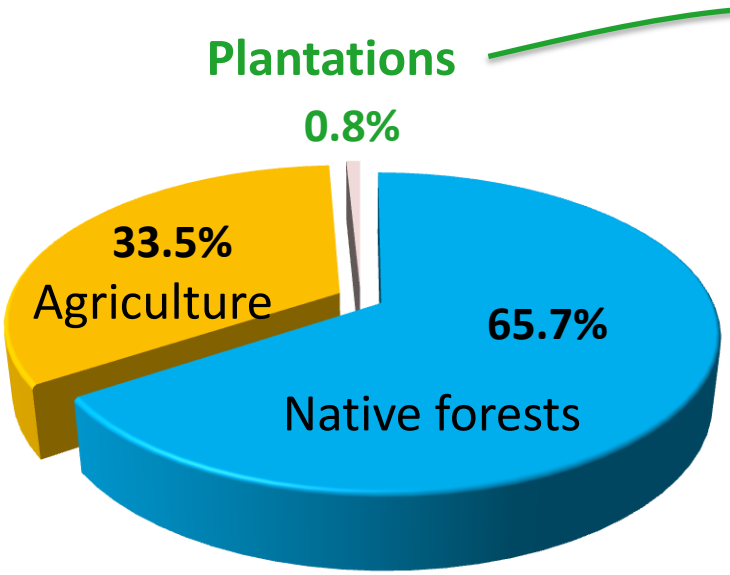
✓ One third (1/3) of the world's charcoal production

✓90% of that is destined to the Brazilian production of pig-iron, alloys iron, pure silicon, among others.

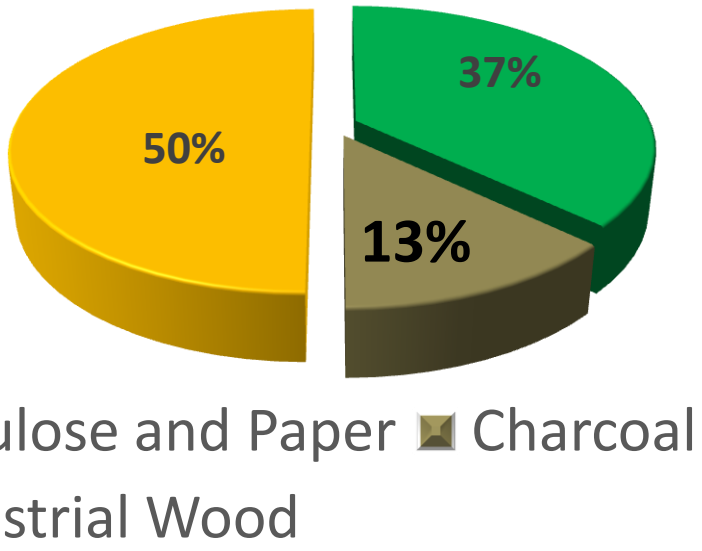
✓80% of the charcoal is still produced through the traditional handcraft method,

✓50% of firewood still derives from native forests.

Charcoal-based pig iron



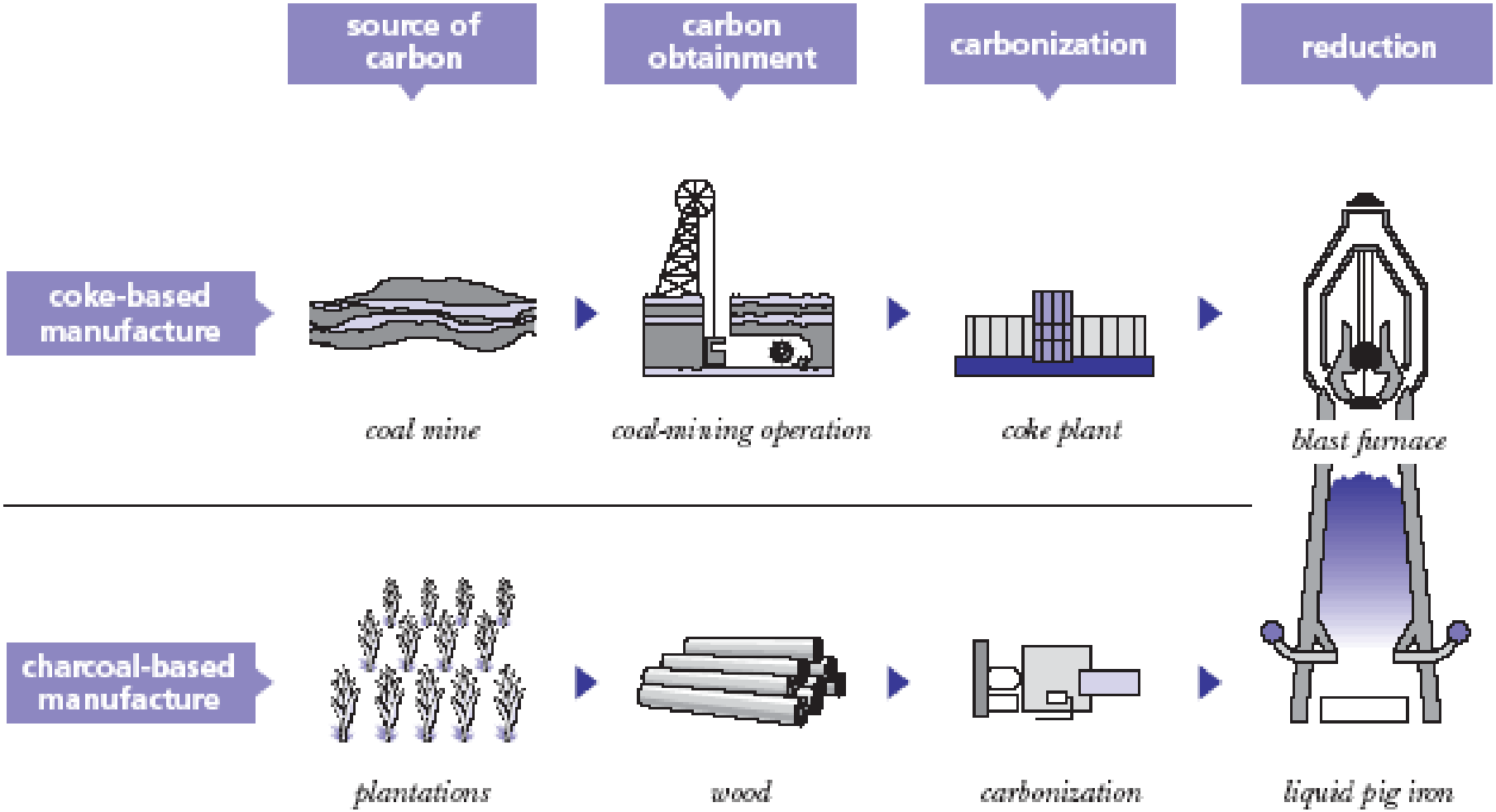
% Brazil's Cover Area (8.5 million km²)



Planted Forest Consumption by Sector

Source: AMS e IBGE,2013

Charcoal-based pig iron



Comparison of coke-based and charcoal-based pig iron manufacture

Charcoal-based pig iron

1 - Matrices Selection

2 - Seedlings Production

3 - Planting & maintenace

4 - Cutting at 7 years

5 - Cross Cutting

6 - Timber transport

7 - Kiln Loading

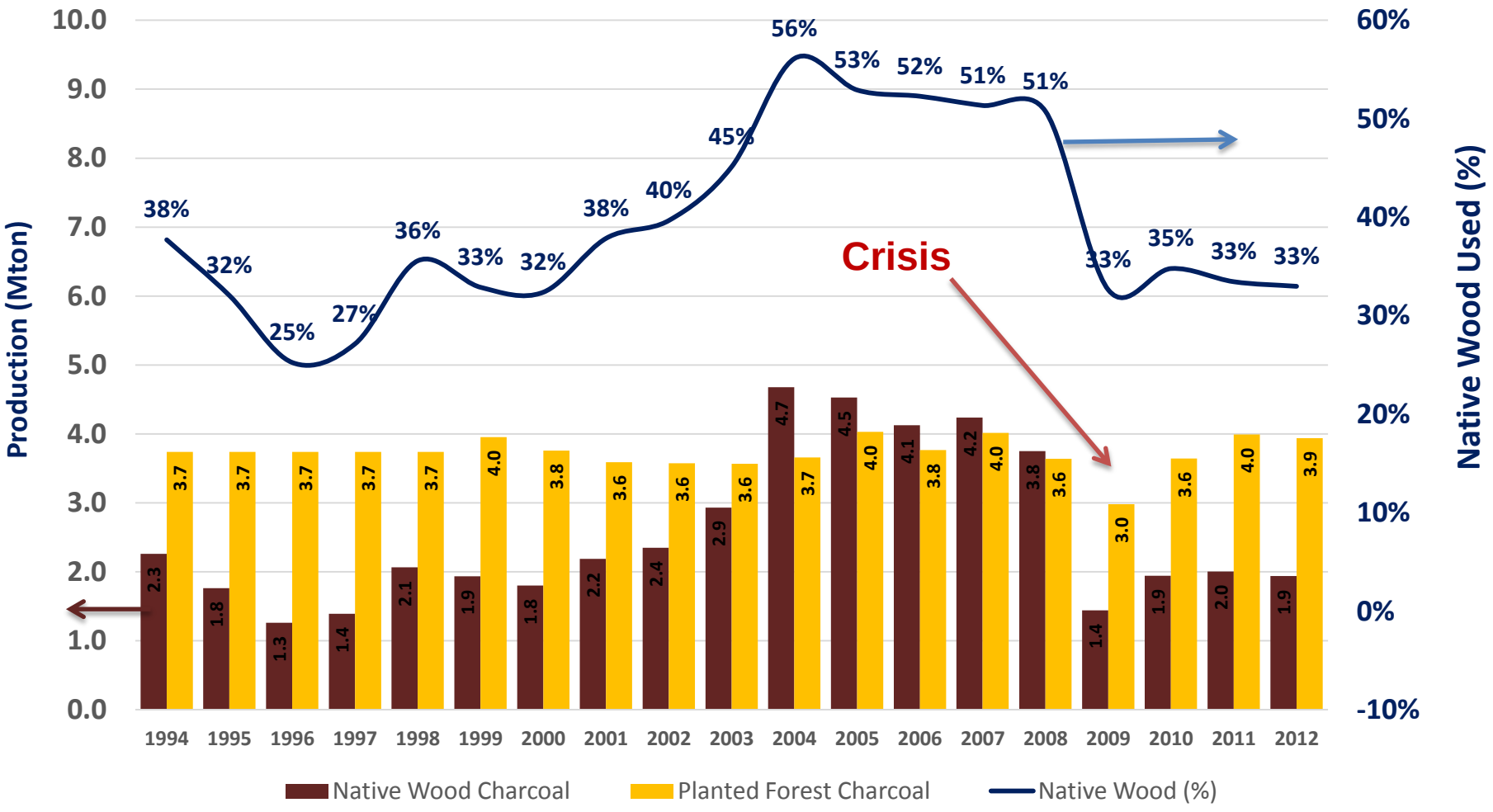
8 - Coaling

9 - Kiln Unloading & Shipment

Flow chart production: from the forest to the blast furnaces

cirad

Charcoal-based pig iron



DEFICIT OF PLANTED FOREST

20.0	Mm^3/year
95000	ha/year

Source: Claret, Raad, 2014

Charcoal-based pig iron

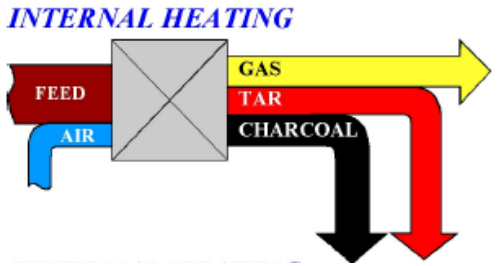
What can we do?

The pressure for ecologically-right, socially fair and economically feasible production has driven the search for cleaner and more efficient technologies.

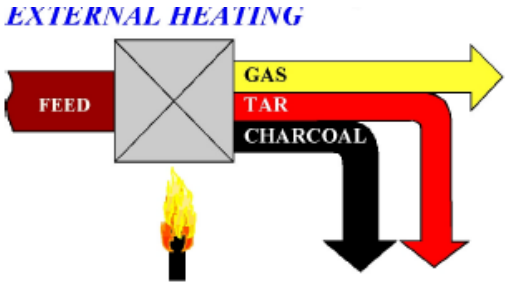
Charcoal-based pig iron

There are more than one hundred concepts and methods to produce charcoal. Three types of heating to initiate the carbonisation and maintain high temperatures during the processes are generally used

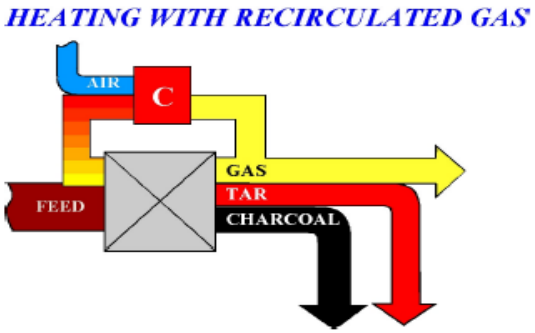
- **1 - Internal heating.** Part of the raw material is burnt under controlled air flow.



- **2 - External heating.** The retort is heated from the outside and no oxygen enters the reactor.



- **3 - Heating with recirculated gas.** Part of the pyroligneous vapours are burnt in an external combustion chamber and directed into the reactor where it is in direct contact with the raw material.



cirad

Charcoal-based pig iron

From traditional methods to…

80% of brazilian charcoal

Industrial methods
(Bricket kilns)

20% of brazilian charcoal

Charcoal-based pig iron

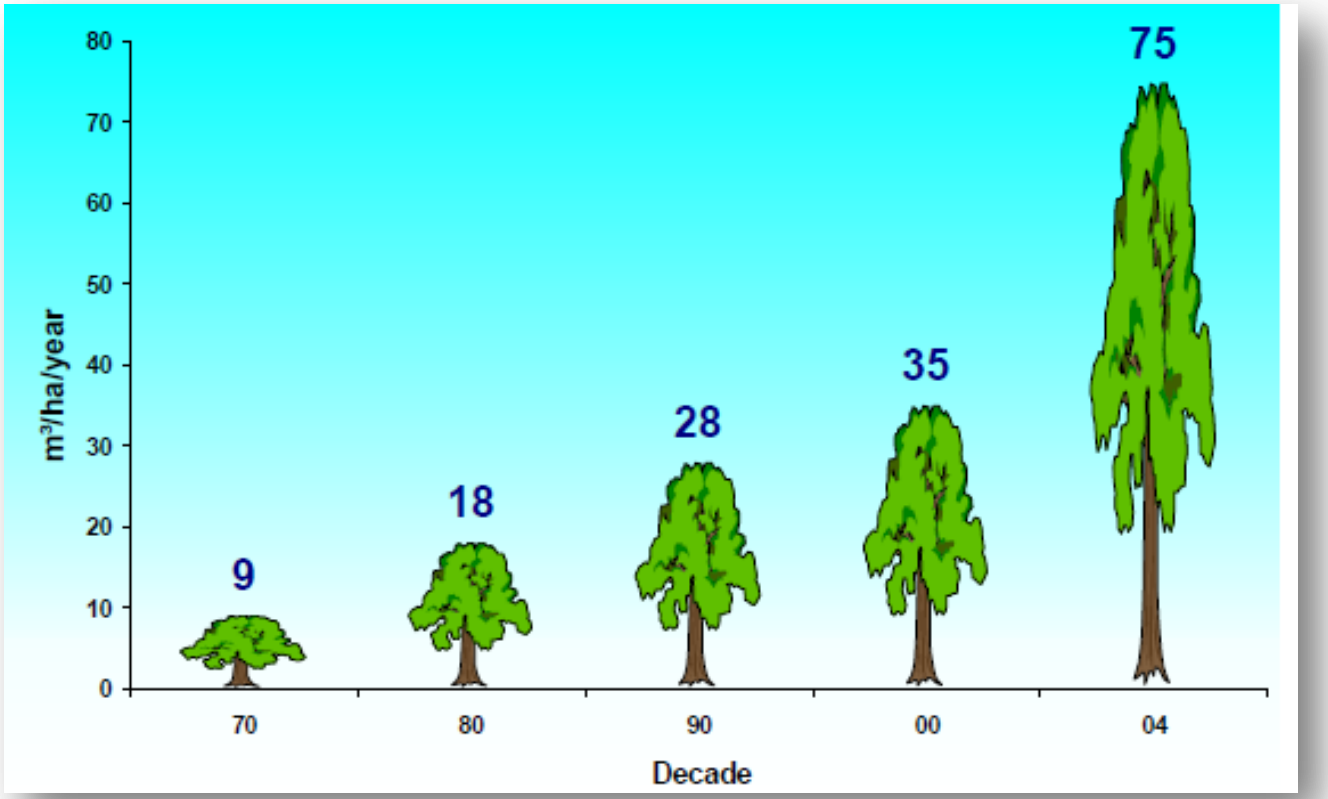
1. Kiln capacity
2. Mechanisation
3. Monitoring
4. Cooling system
5. Emissions
6. Combustion
7. Drying
8. Logistics
9. Cogeneration

IMPROVEMENT OF BRICKET KILNS AND QUALITY CHARCOAL

cirad

Charcoal-based pig iron

Plantation productivity



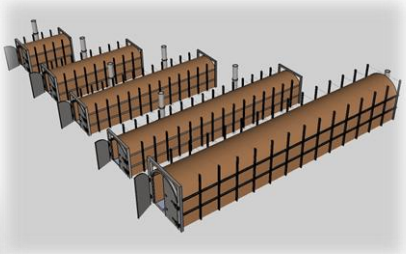
Average annual increase of Acesita Energética forests since 1970 (m^3/ha/year)

Source: Acesita, 2008

Charcoal-based pig iron

Bricket kilns size

100m³



Economy scaling-up

200m³

400m³

800m³

daniel@barcelloscamara.com.br

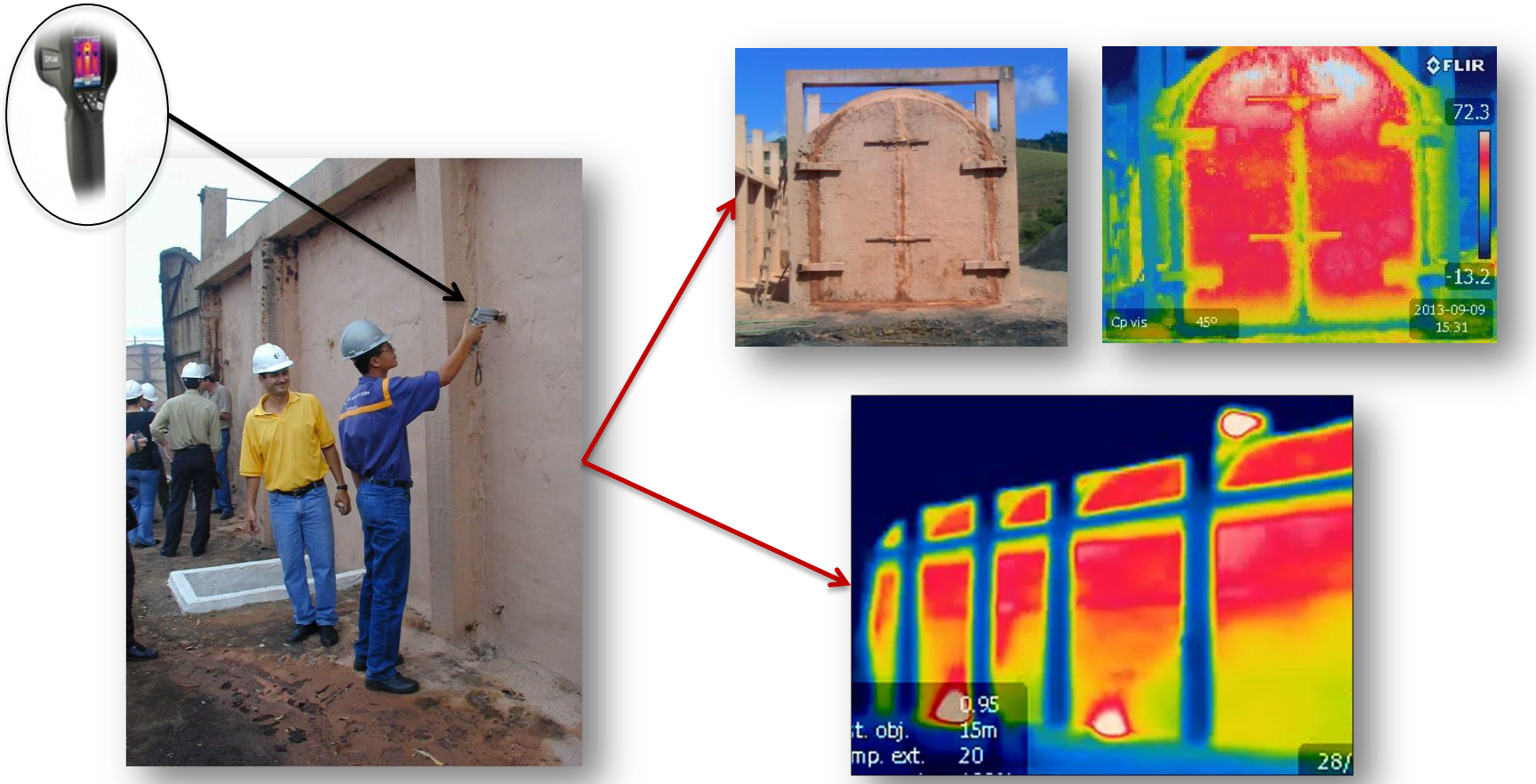
Complete mechanization

Unloading

Shipement

daniel@barcelloscamara.com.br

Control of pyrolysis phases



Kiln thermal profiles to control the evolution of wood drying and pyrolysis during the whole process

Charcoal-based pig iron

Mud

Mud

Air

Air + water

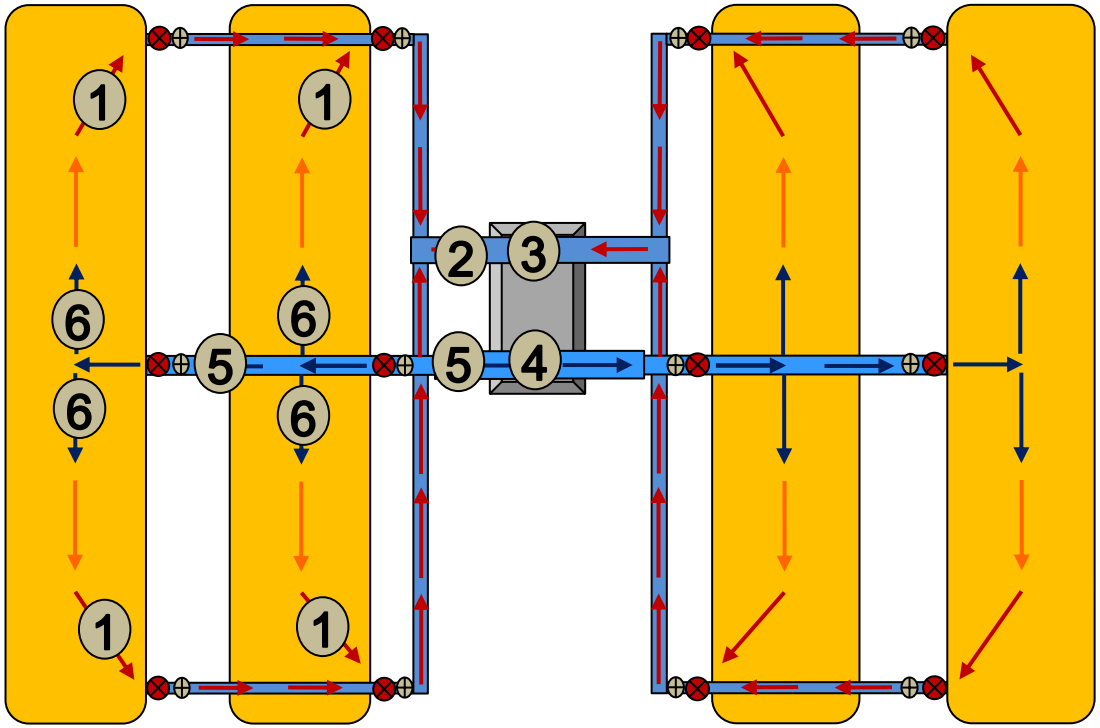
Air /Air

Air /Air

Cooling system improvement

daniel@barcelloscamara.com.br

Cooling system

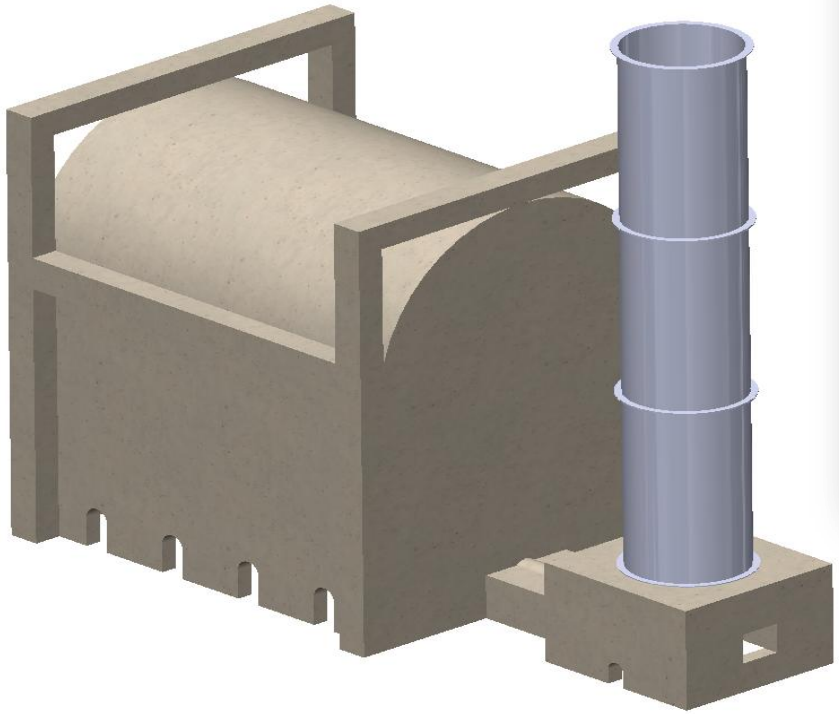


1 - Hot gases from kiln
2 - Exchanger inlet
3 &4 - Exchange air/air
5 – Exhanger outlet
6 – Injection of cooled gases

daniel@barcelloscamara.com.br

Charcoal-based pig iron

Gas burning



Combustors: Pilot/laboratory scale

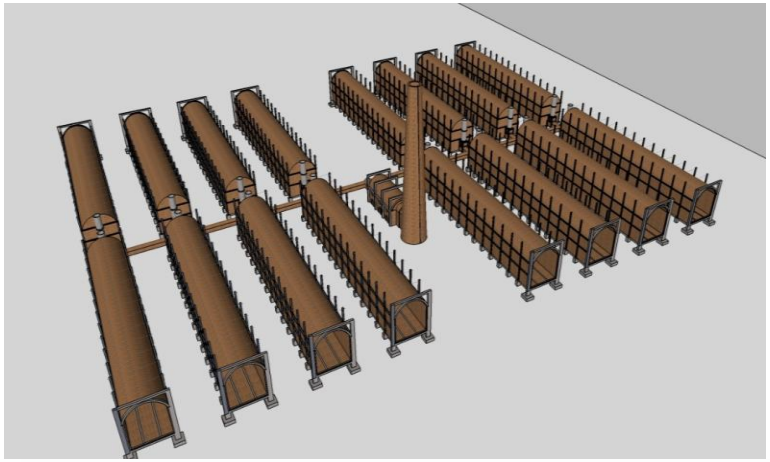
daniel@barcelloscamara.com.br

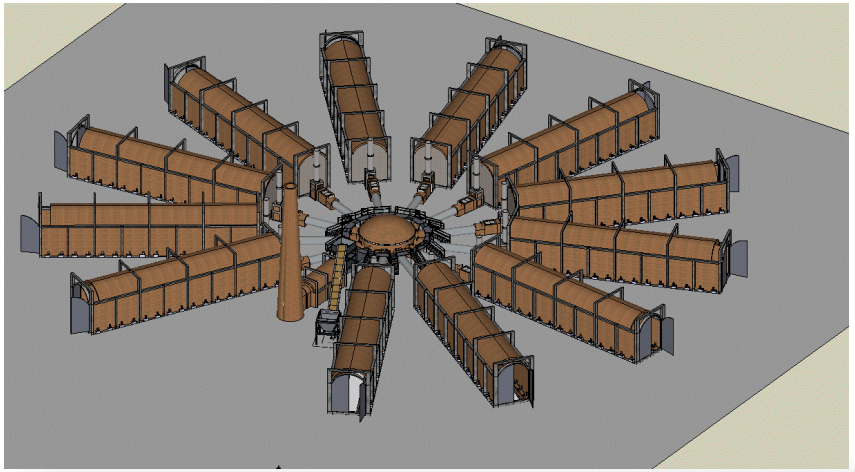
Gas burning

Industrial Brick and metallic combustors

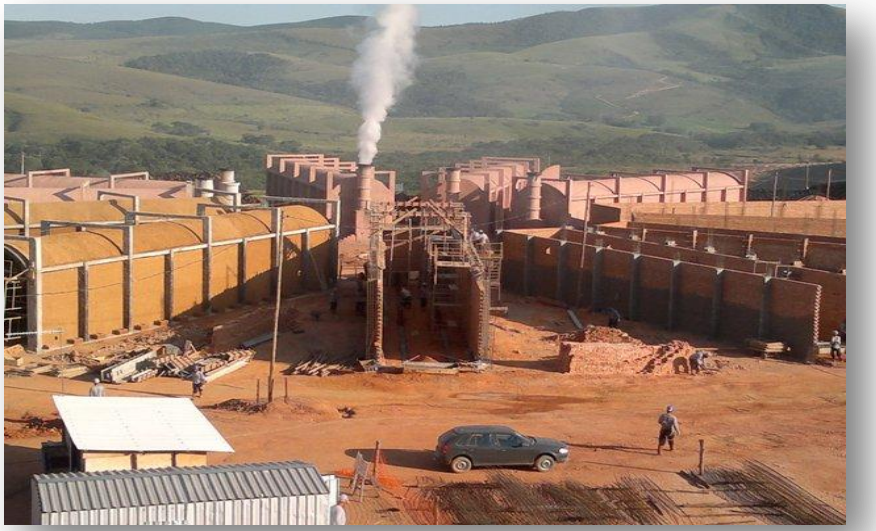
daniel@barcelloscamara.com.br

Gas burning: logistics





Linear

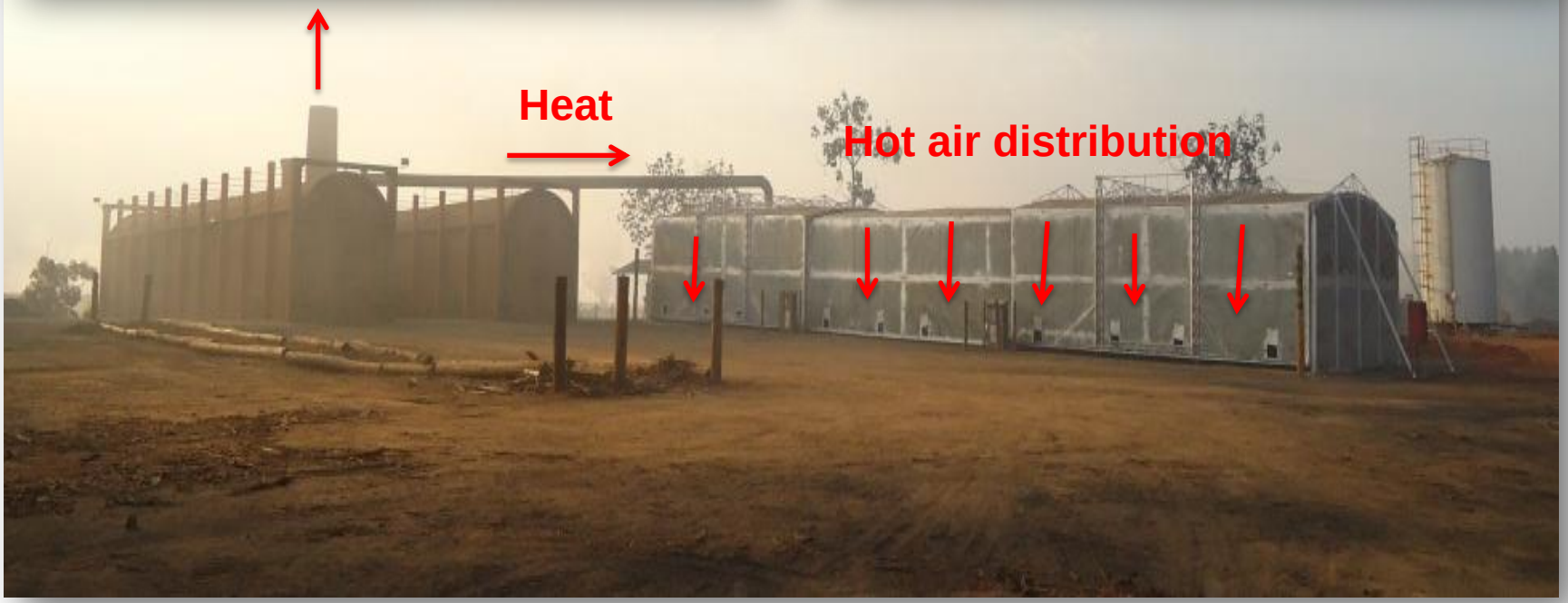


Circular

daniel@barcelloscamara.com.br

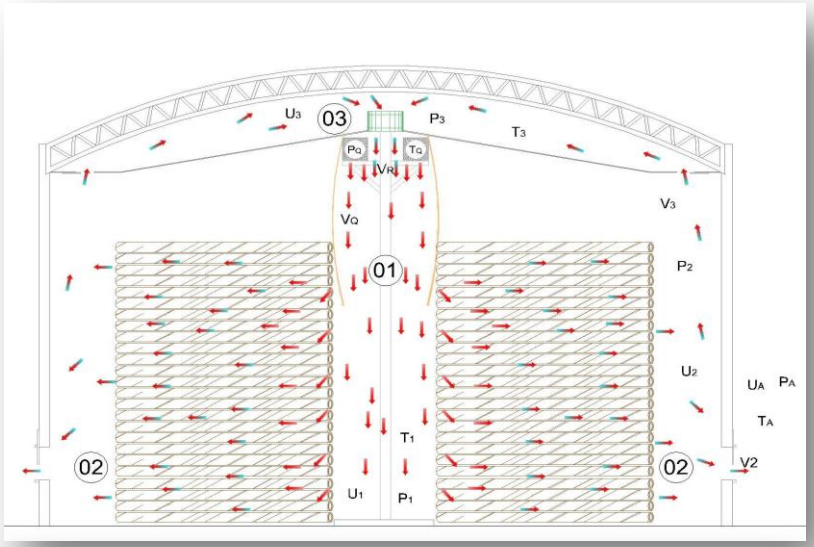
Wood drying

Charcoal-based pig iron



daniel@barcelloscamara.com.br

Charcoal-based pig iron



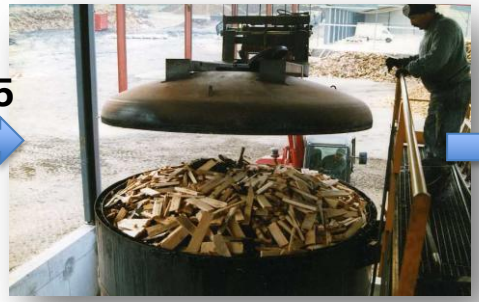
WOOD DRYING PROCESS

Charcoal-based pig iron

Cogeneration & electricity production

Biomass : **100%**

0,45



Pyrolysis gas : 45%

0,8

Heat: 36%

0,8

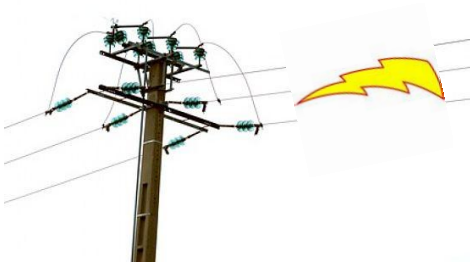
Steam: 29%

0,4

Steam/meca. 12%

0,8

Meca./Elec 9%



Charcoal-based pig iron

Cogeneration & electricity production

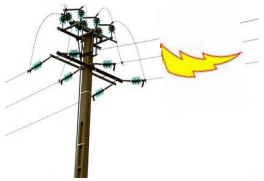
WOOD:
- 15.000 T
- Moisture < 20%

PROCESS:
- Standard unit :12 kilns
- Total volume : 200m^3
- Carbonization cycle : 24 hours

CHARCOAL:
3000 T

FINES
300 T

Energy contained in the fumes
3.6MWth

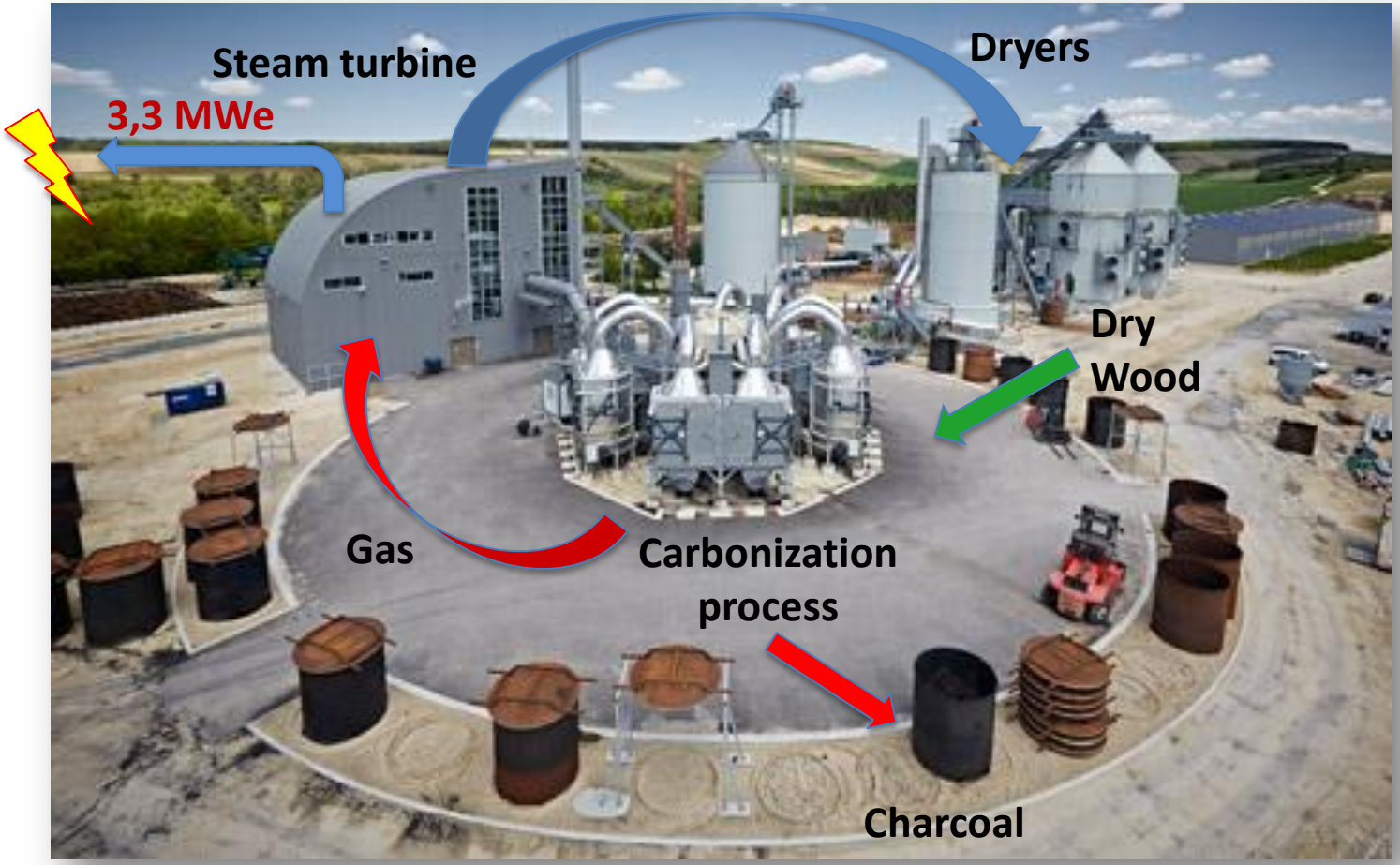


360kW elect

Source:http://www.cogebio.com/produits-cogeneration.php

Siderurgy based on charcoal

Cogeneration & electricity production

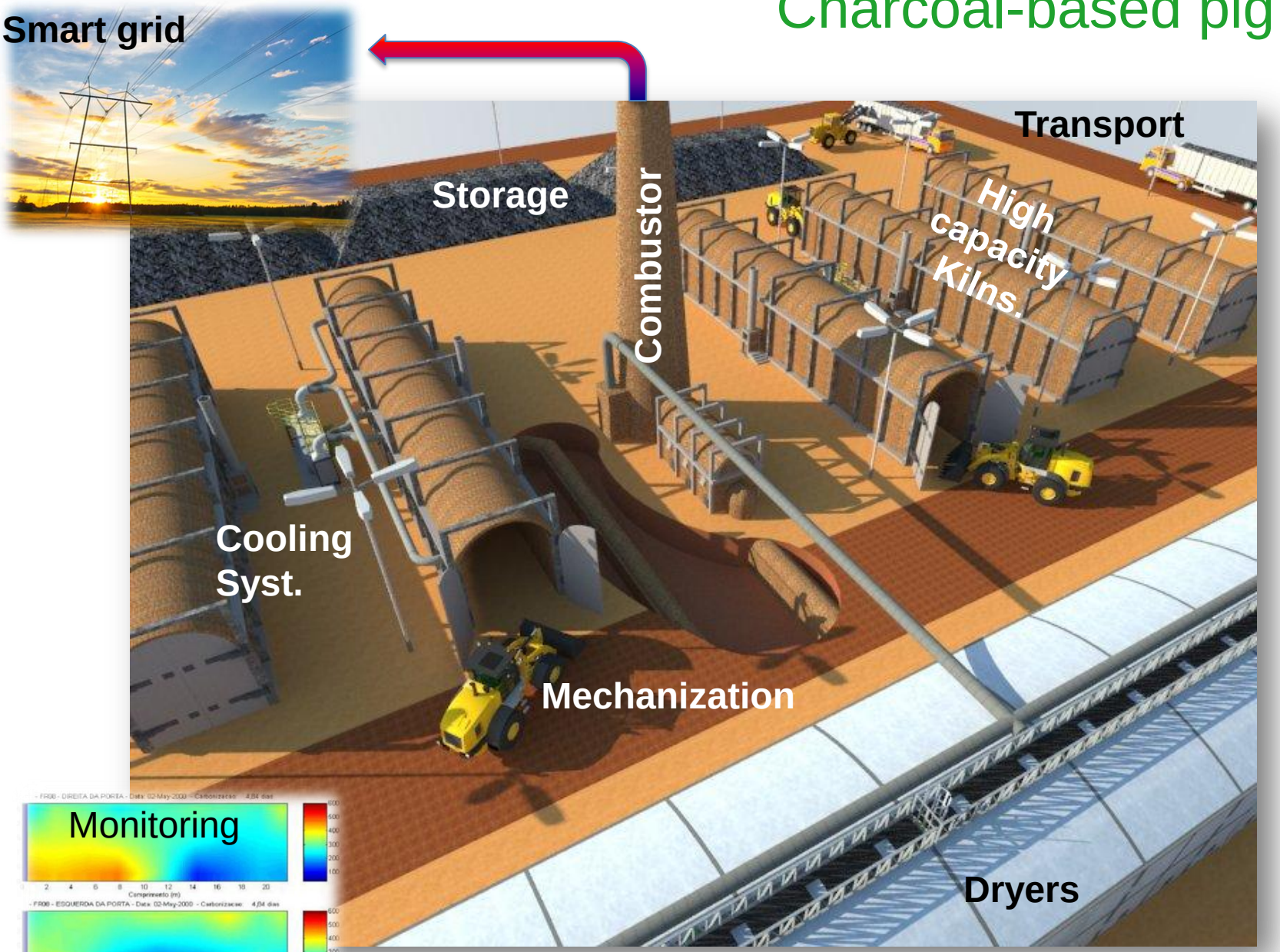


Source: http://www.carbonex.fr/technologie---innovation.html

Cogeneration & electricity production

Source: http://www.carbonex.fr/technologie---innovation.html

Charcoal-based pig iron



Ideal charcoal plant

daniel@barcelloscamara.com.br

This visualization shows how global temperatures have risen from 1950 through the end of 2013. NASA scientists say 2013 tied for the seventh warmest of any year since 1880.

Thank you for your attention

Patrick.rousset@cirad.fr